

SUSTAINABLE CITIES
U.S.-Australia Dialogue, 1-19-11

***White Roofs to Cool your Buildings, and Cities and
(this is new) Cool our Planet***

**Arthur H. Rosenfeld, Former Commissioner
California Energy Commission.**

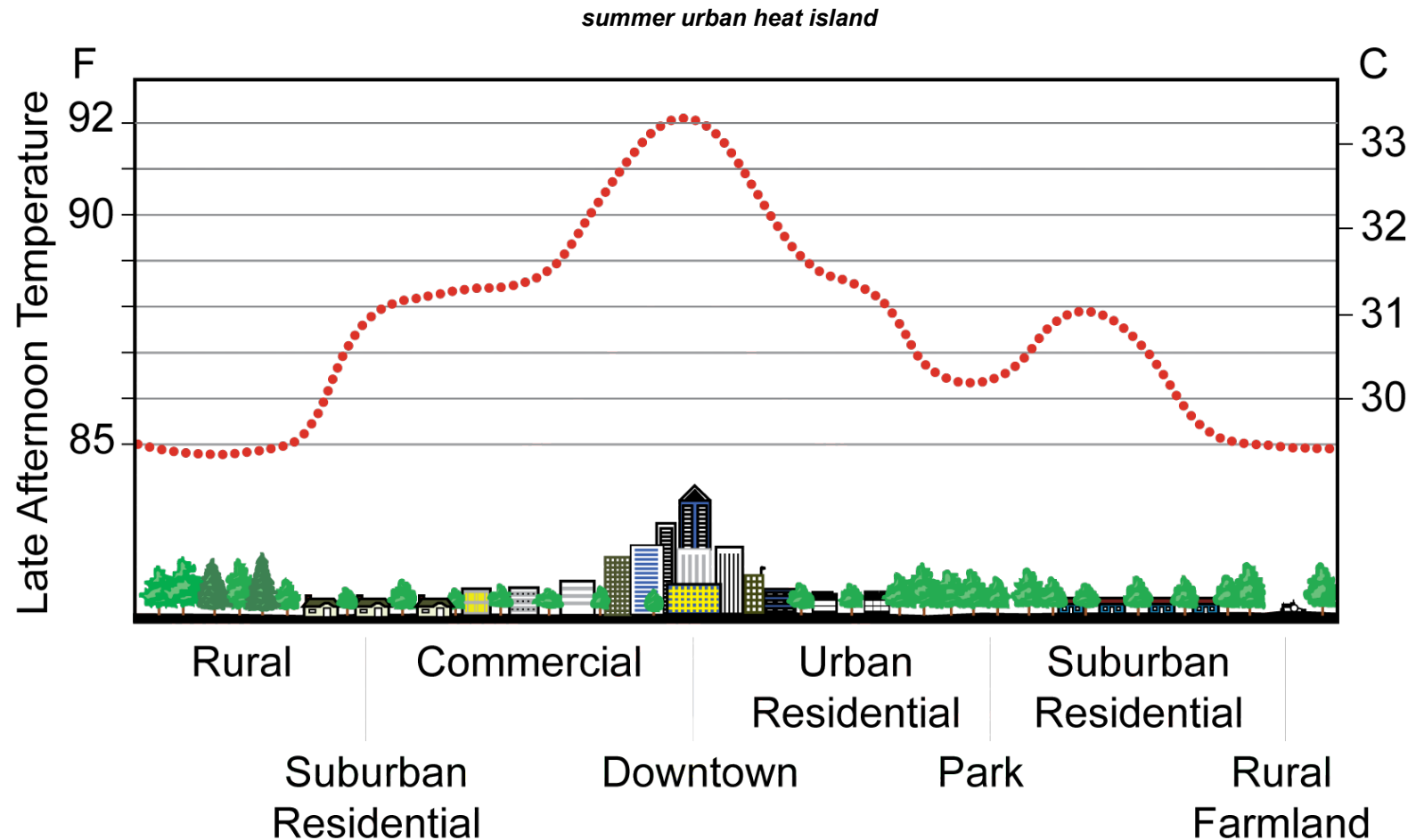
**Distinguished Scientist Emeritus
Lawrence Berkeley National Lab.**

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Presentation available at www.ArtRosenfeld.org

Summer in the city



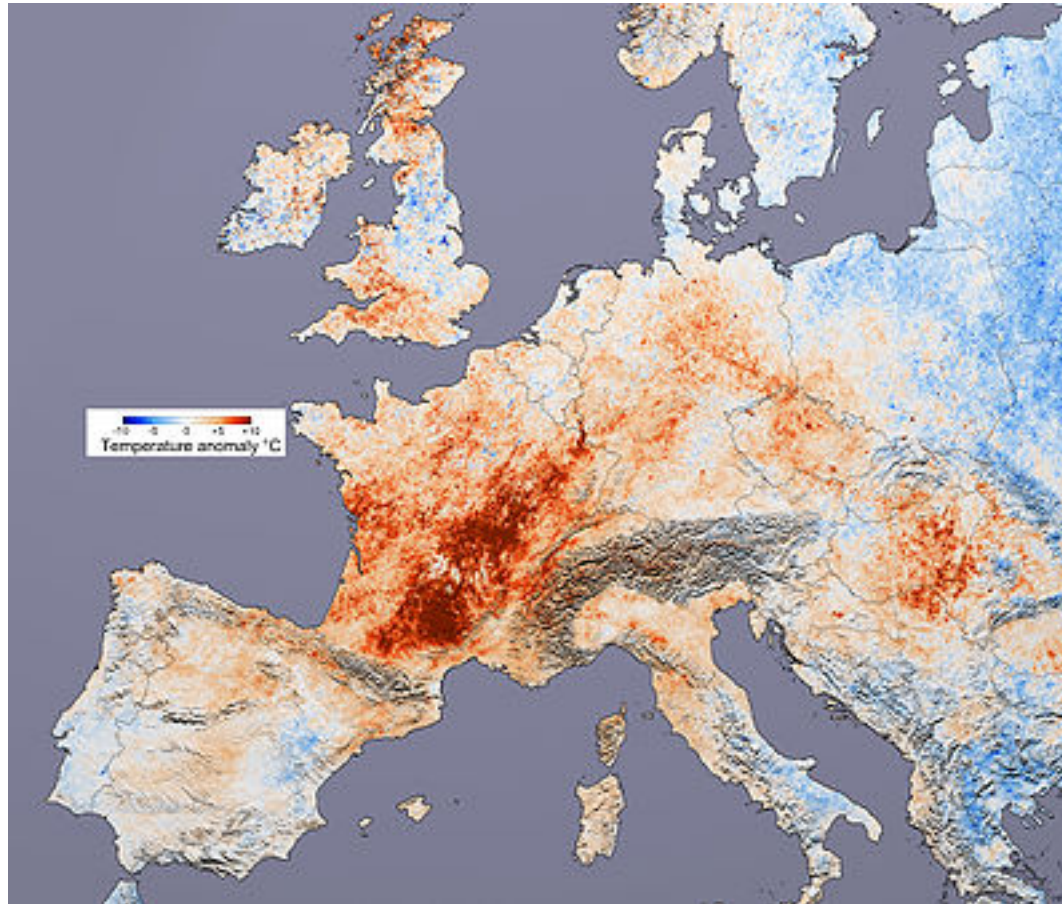
Chicago Heat Wave 1995, 739 Deaths

Virtually all of the deaths occurred on the top floors of buildings with black roofs



European Heat Wave 2003, 30,000 Deaths

France July 2010, Few Deaths

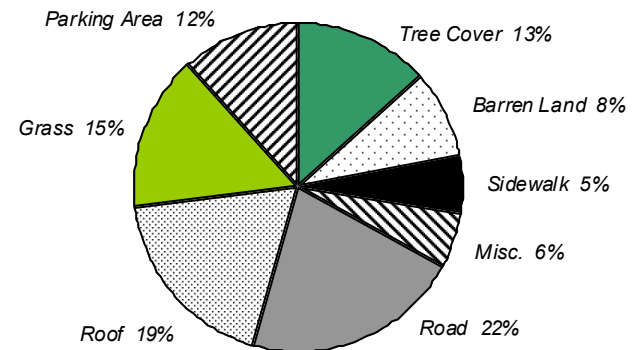


Bird's eye view of urban land use



The surface of Sacramento, CA is about

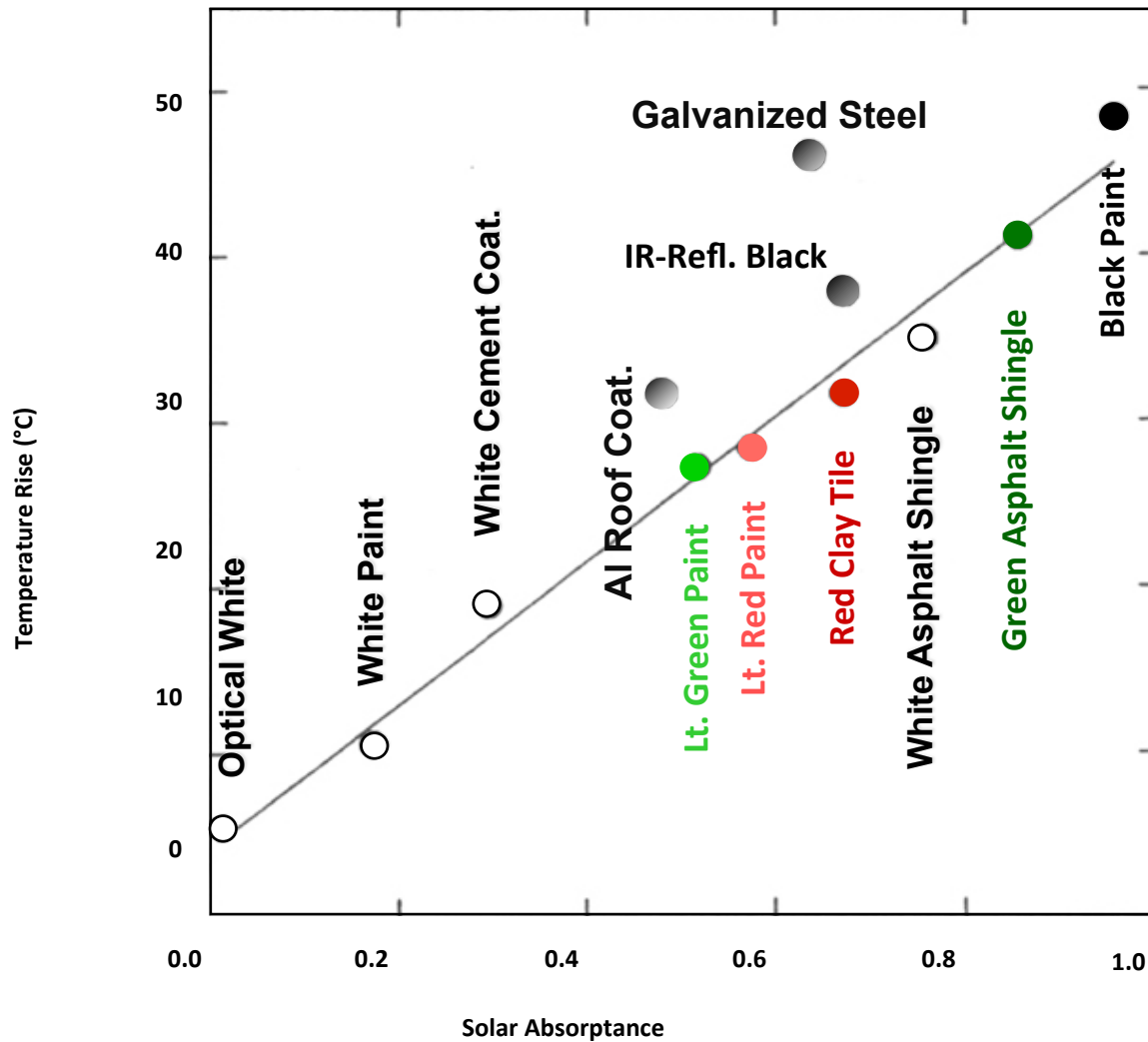
- **20% roofs**
- **30% vegetation**
- **40% pavement**



Area by Land-Cover Category Above the Canopy

~ 1 km²

Reflective roofs stay cooler in the sun



White roofs around the world

...in Santorini, Greece



...in Hyderabad, India

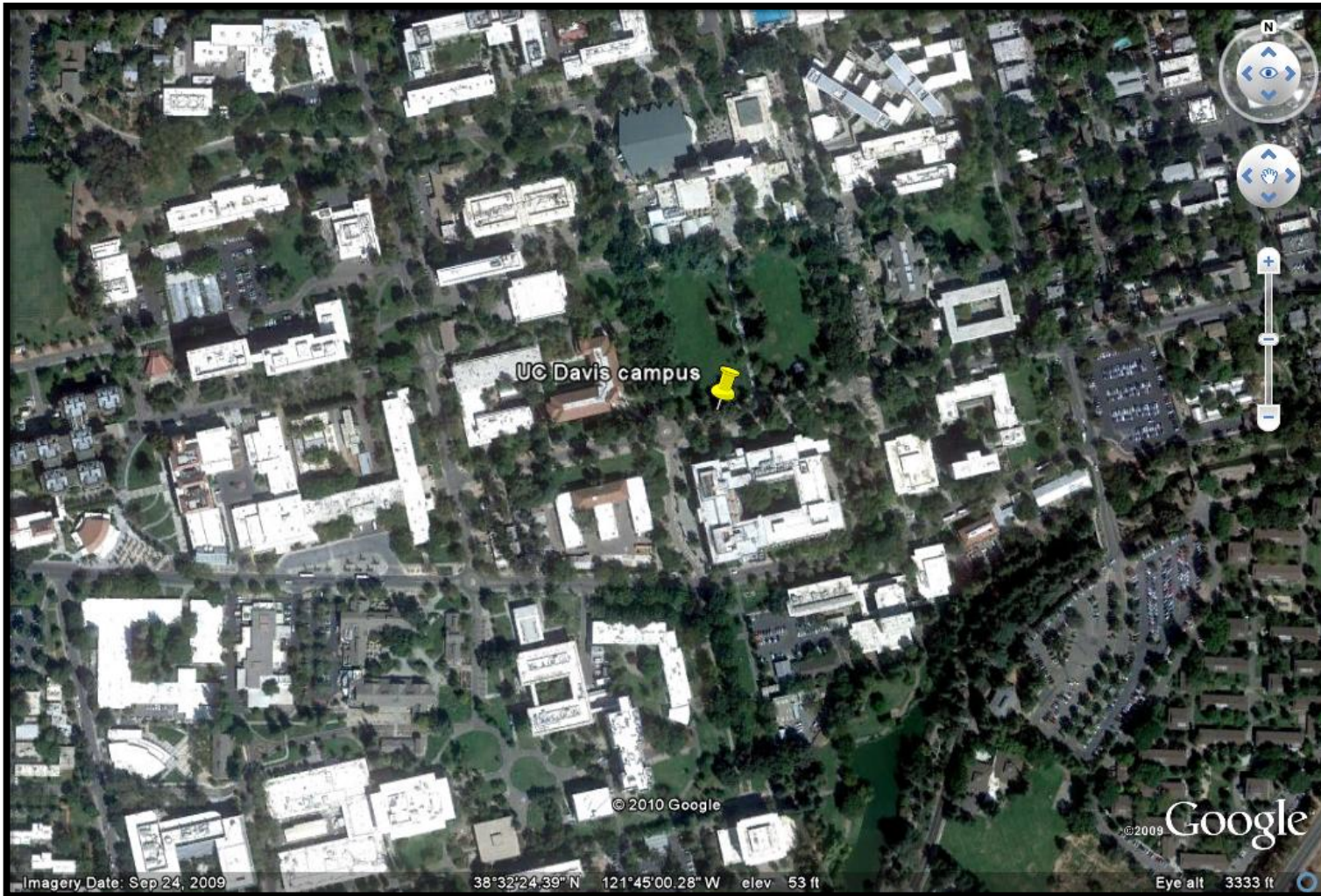


**...and widely
in the state of
Gujarat, India.**

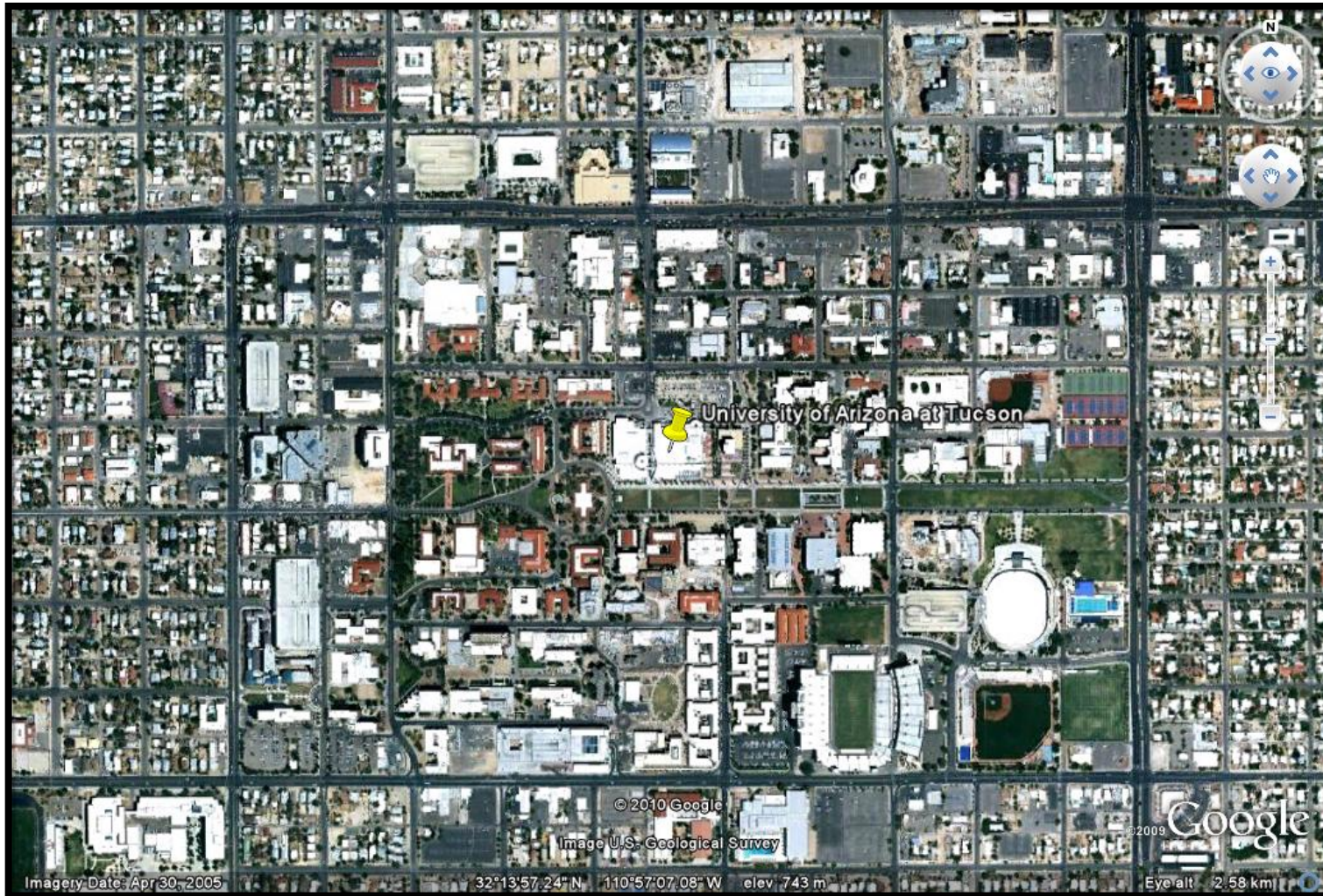
Walmart store in northern California



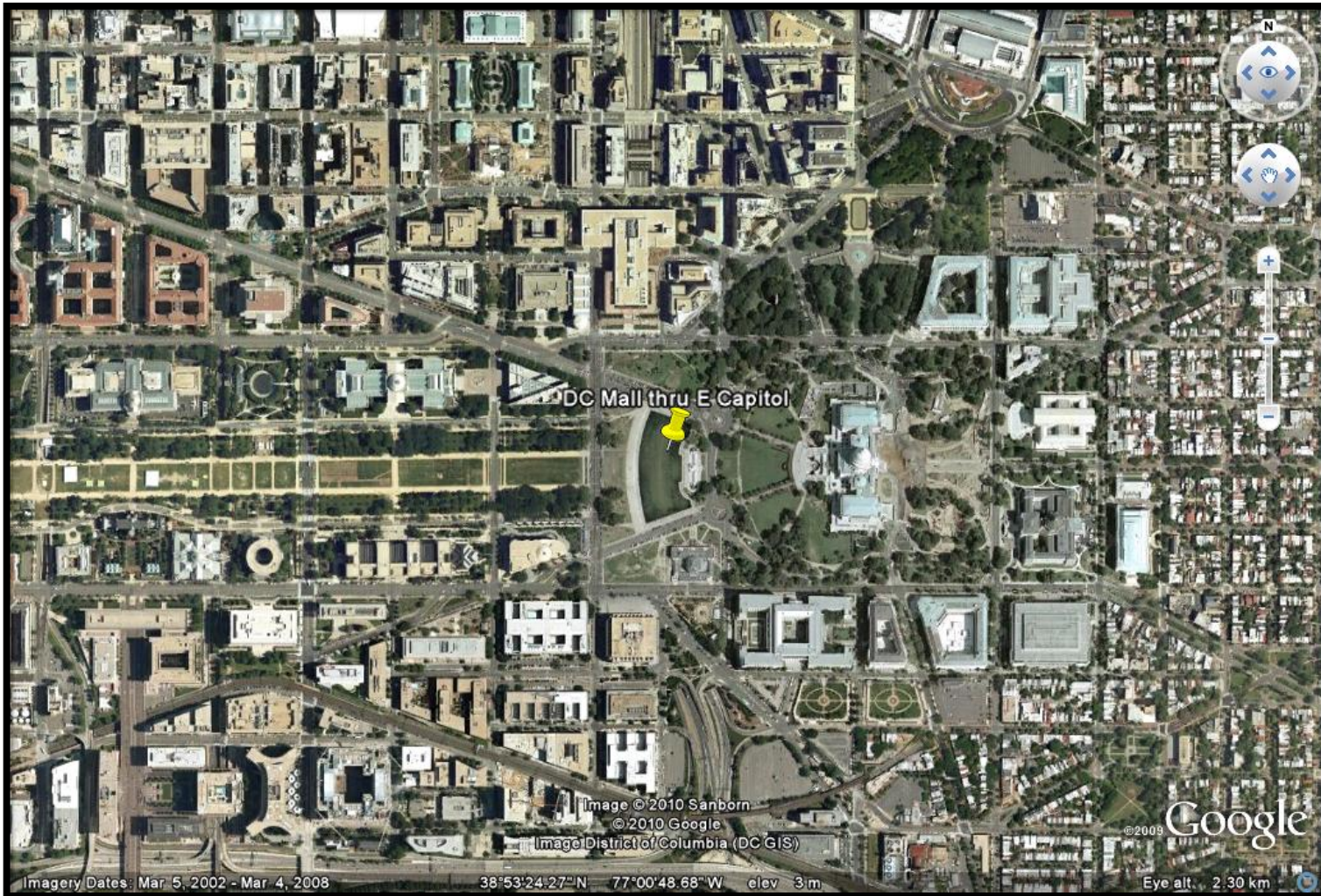
Congratulations to UC Davis



White roofs are popular in Tucson, AZ



Washington, DC (Federal) has problems

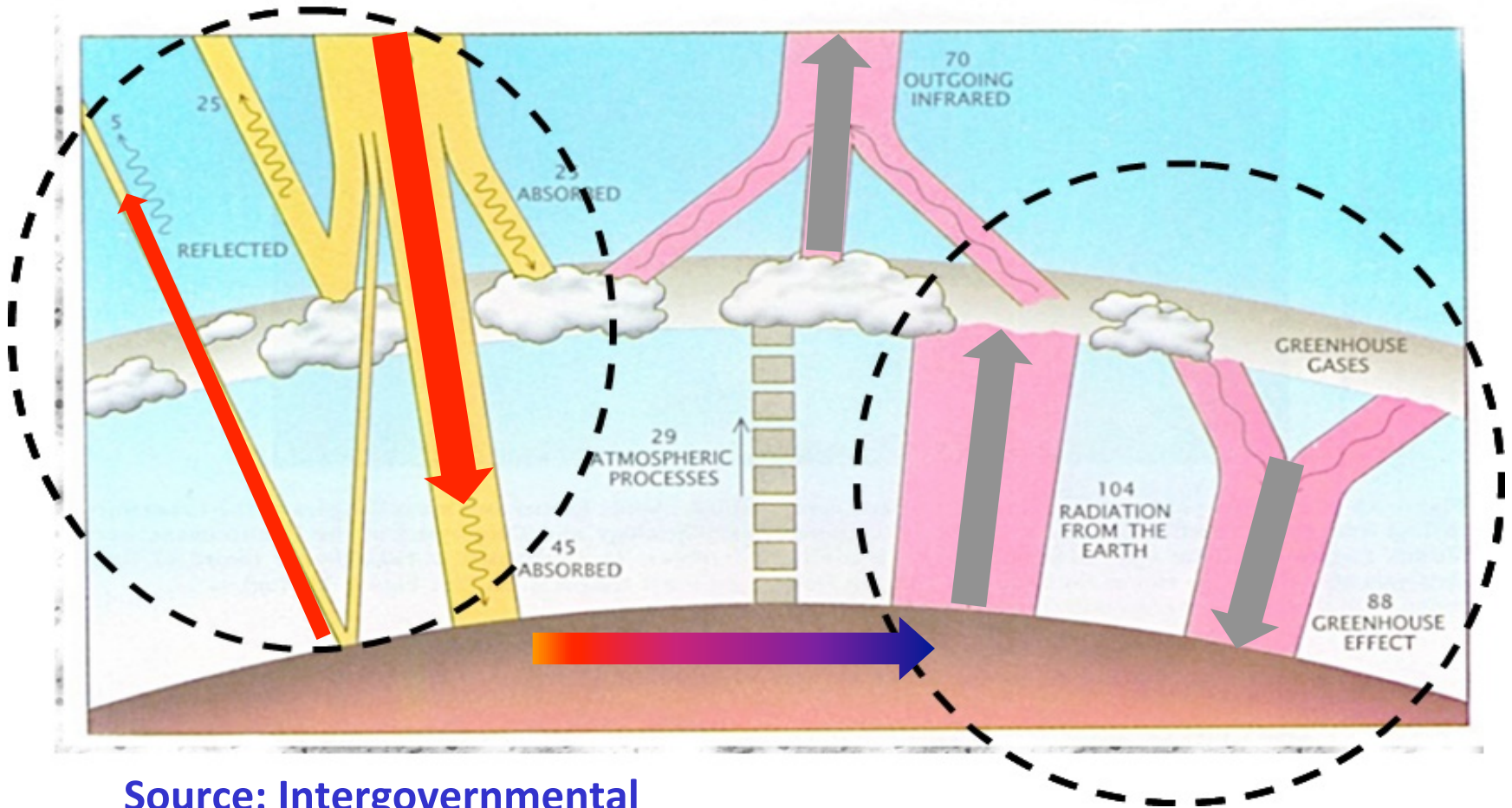


Pentagon



Cooling our planet

Solar-reflective surfaces cool the globe via “negative radiative forcing”



Source: Intergovernmental
Panel on Climate Change (IPCC)

GLOBAL COOLING: making 100 m² (1000 ft²) of gray roofing white offsets the **emission** of 10 t of CO₂



How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs worldwide? (i/ii)

- Answer: **24 Gigatonnes (Gt)**
 - 2/3 of a year's worldwide emission
 - Gigatonne = billion metric tons
- If implemented over 20 years (the life of a roof or a program) this is ≈ 1.2 Gt/year.

How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs world-wide? (ii/ii)

- Offset is equivalent to **taking 300 million cars off the road for 20 years.**
 - There are about 600 million passenger cars world wide, and they each emit $\approx 4 \text{ t CO}_2/\text{year}$.





LAWRENCE BERKELEY NATIONAL LABORATORY PRESENTS:
SCIENCE AT THE THEATER

COOL CITIES, COOL PLANET

What to do now

Progress in energy efficiency standards

- In 2005, California's "Title 24" energy efficiency standards prescribed white surfaces for low-sloped roofs on commercial buildings. Several hot states are following.
- In 2008, California prescribed "cool colored" surfaces for steep residential roofs in its 5 hottest climate zones.
- **Other U.S. states & all countries with hot summers should follow.**

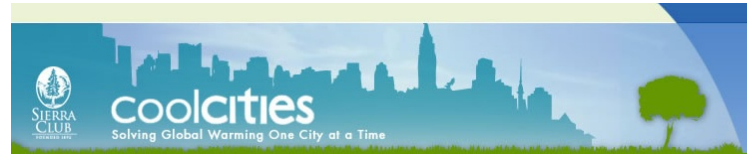
Recent cool roof progress (2005 – 2011)

- 2005
 - California Title 24 – “Flat roofs shall be white” (15 out of 16 climate zones). Walmart adopts white roofs for ALL stores.
 - EPA ENERGY STAR lists Cool Roof Materials
- 2010
 - June 1st, 2010 – Memo from U.S. Energy Secretary Steven Chu calls for all DOE Buildings to have white roofs, if cost-effective
 - June 16th, 2010 – Marine Corp follows suit, Pentagon following slowly
 - June 19th, 2010 – *RetroFIT Philly* announces winner of “coolest block” contest to white-coat black roofs of row houses.
- 2011
 - 100 Cool Cities launched – see www.WhiteRoofsAlliance.org
 - Spring 2011 – US will launch, at G20 Energy Ministers meeting, a voluntary Cool Roofs initiative and may even offer technical assistance to developing countries who join early.

To come 2012...

- Model codes will be modified to prescribe “flat roofs shall be white”
 - ASHRAE for commercial buildings
 - EECC for residential buildings
- But states and cities have to adopt model codes

100 Cool Cities could unite many initiatives and trade associations



EMERALD CITIES COLLABORATIVE
GREEN • FAIR • DEMOCRATIC



American Council for an Energy-Efficient Economy

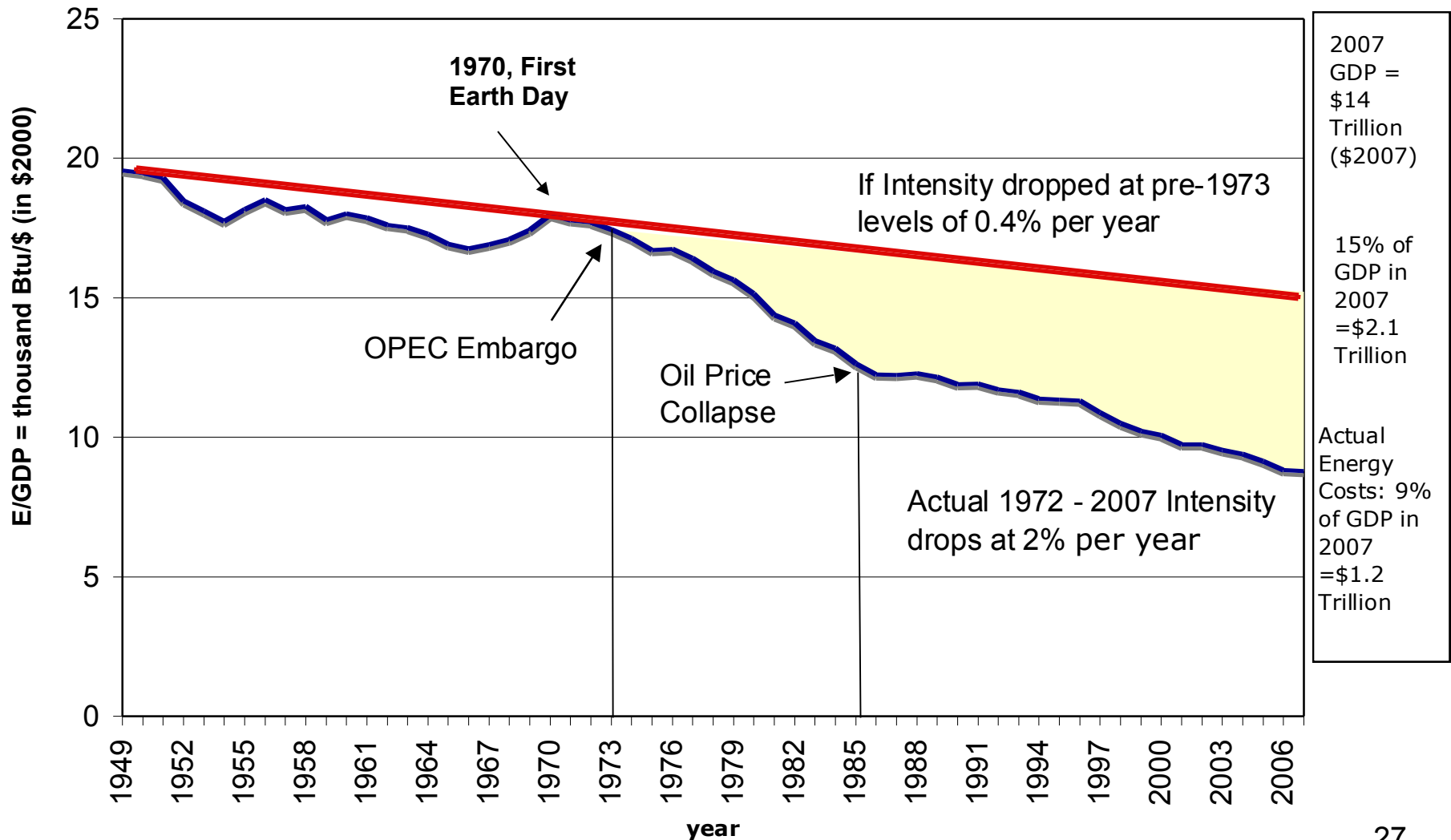
THE CLIMATE GROUP

Resources on the web

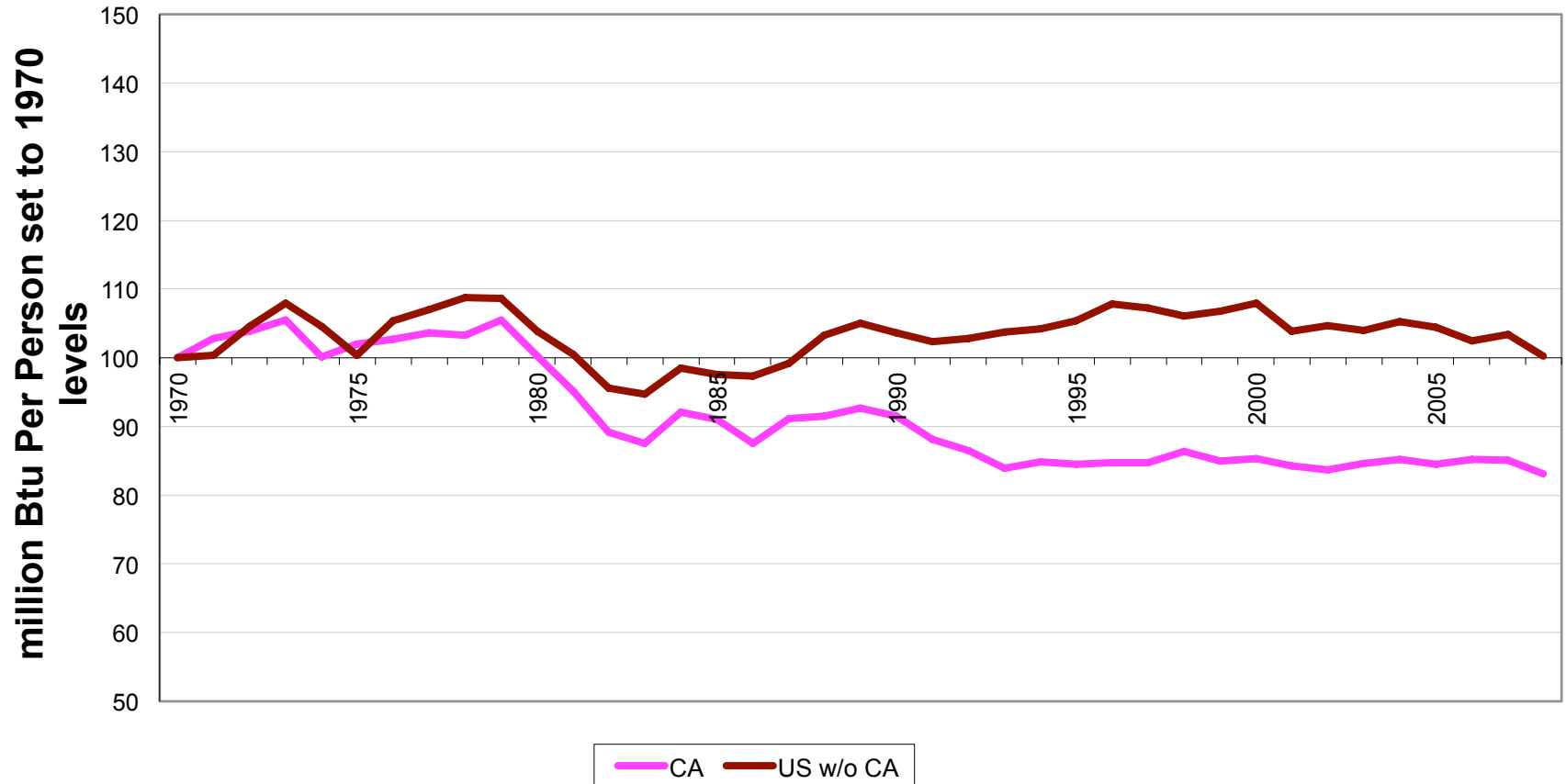
- **Art Rosenfeld's website**
 - ArtRosenfeld.org
- **Cool Colors Project**
 - CoolColors.LBL.gov
- **Heat Island Group**
 - HeatIsland.LBL.gov
- **Cool Communities Project**
 - CoolCommunities.LBL.gov
- **Roof Savings Calculator**
 - RoofCalc.com
- **White Roofs Alliance**
 - WhiteRoofsAlliance.org
- **Cool Roof Rating Council**
 - CoolRoofs.org
- **Cool California**
 - CoolCalifornia.org
- **EPA Heat Islands**
 - epa.gov/heatisland
- **Energy Star Cool Roofs**
 - EnergyStar.gov

Energy Efficiency & Demand Response

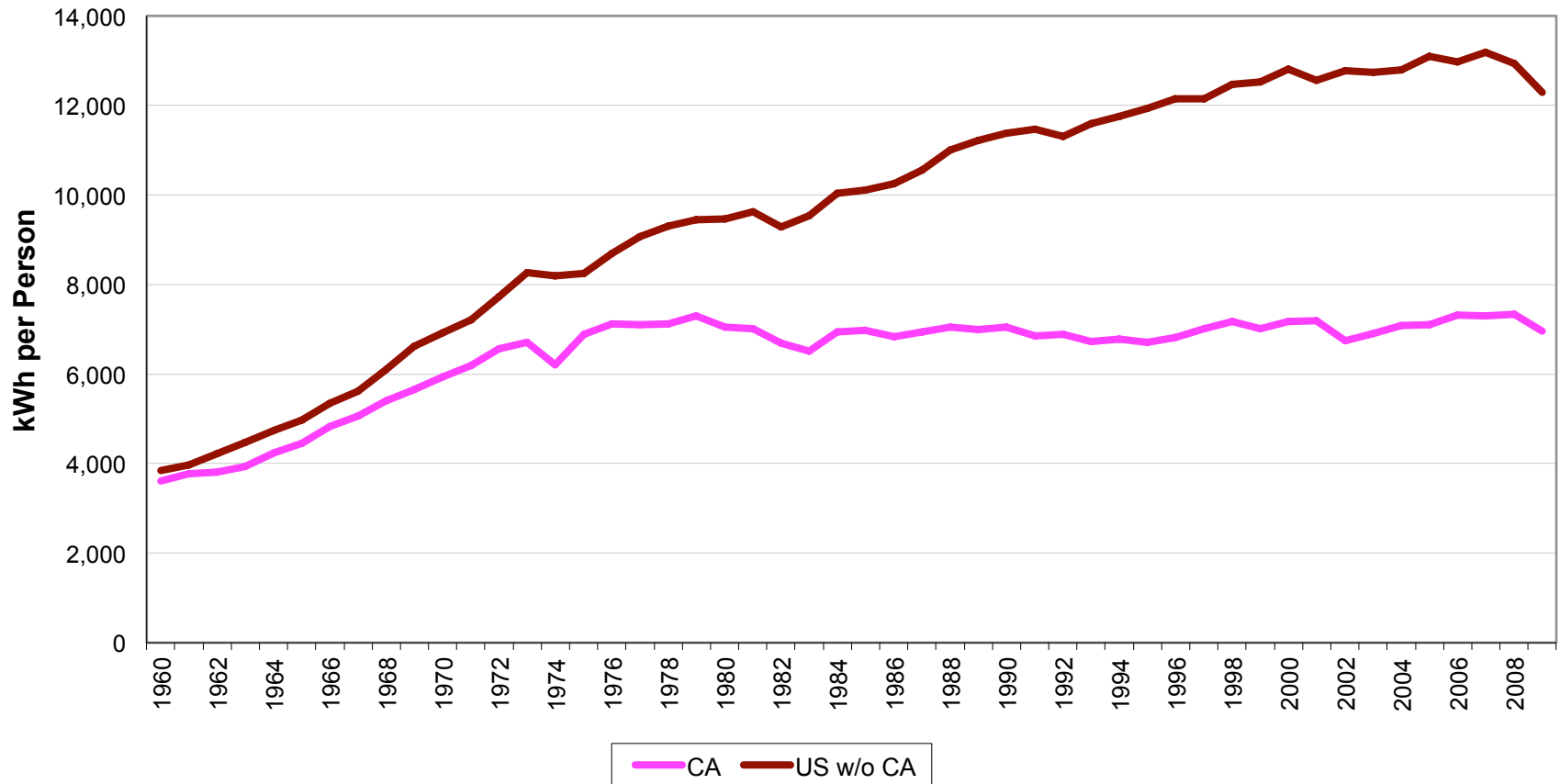
Energy Intensity (E/GDP) in the US 1949 - 2007



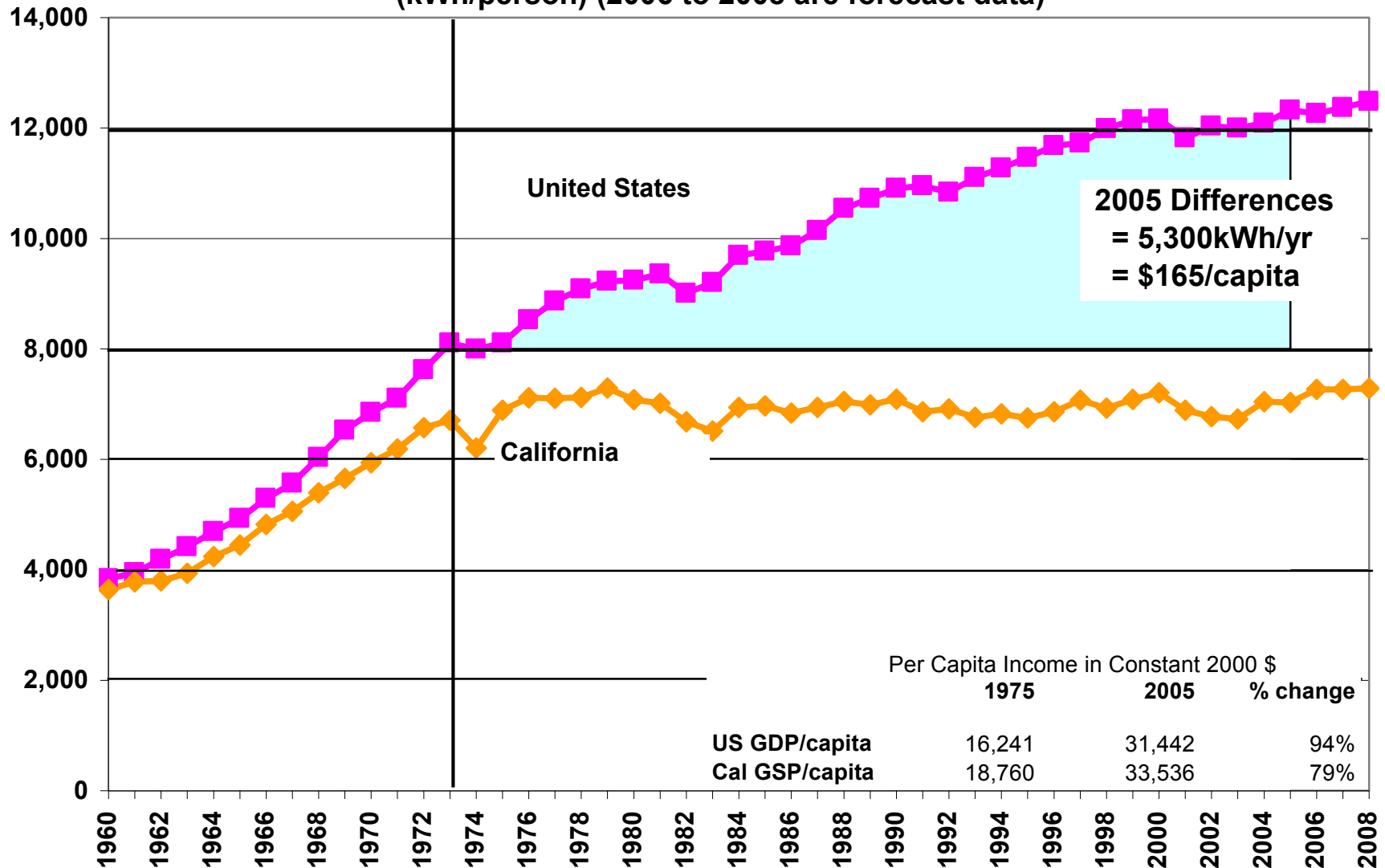
CA vs US Energy Consumption Per Capita



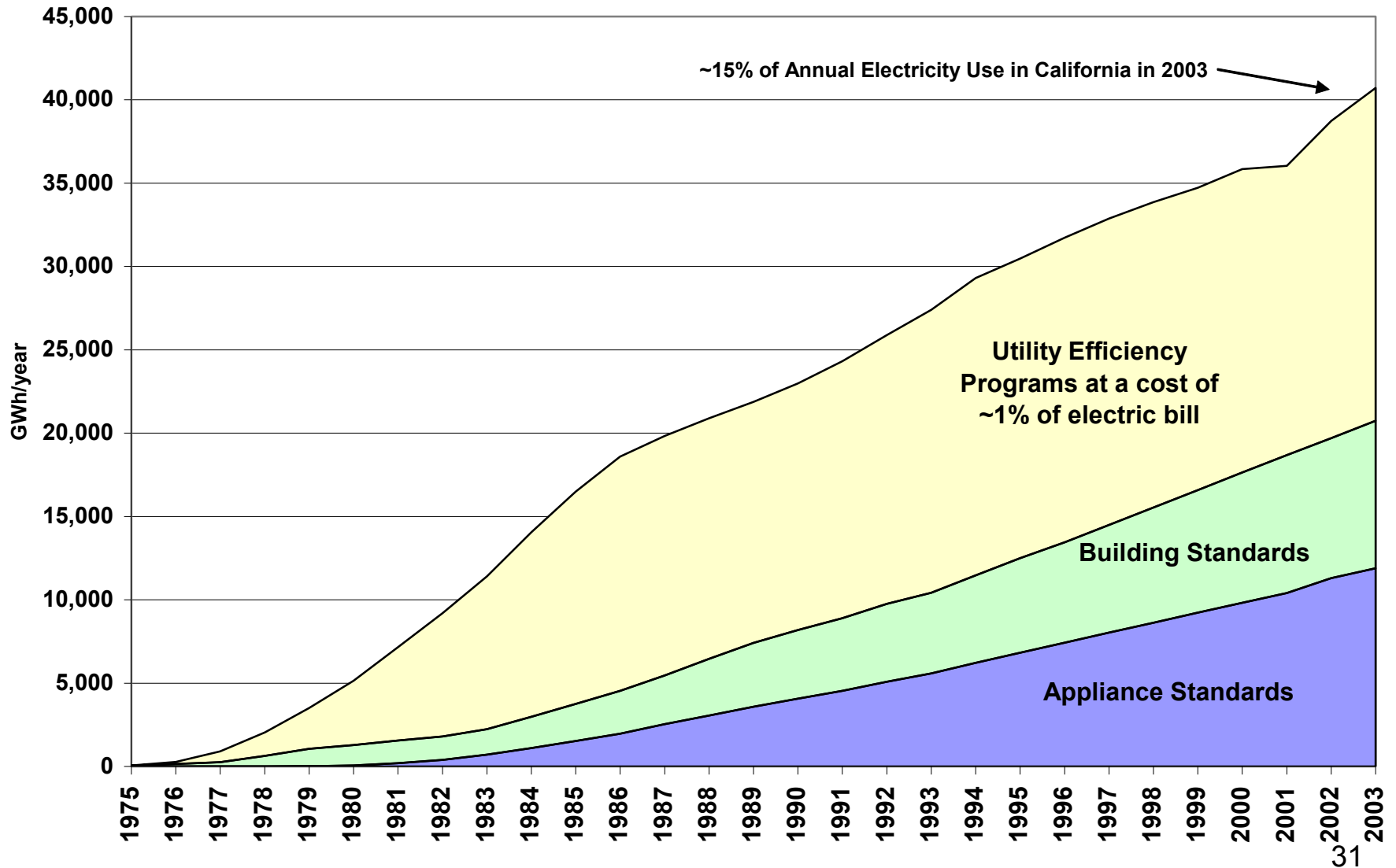
CA vs US Electricity Consumption Per Capita



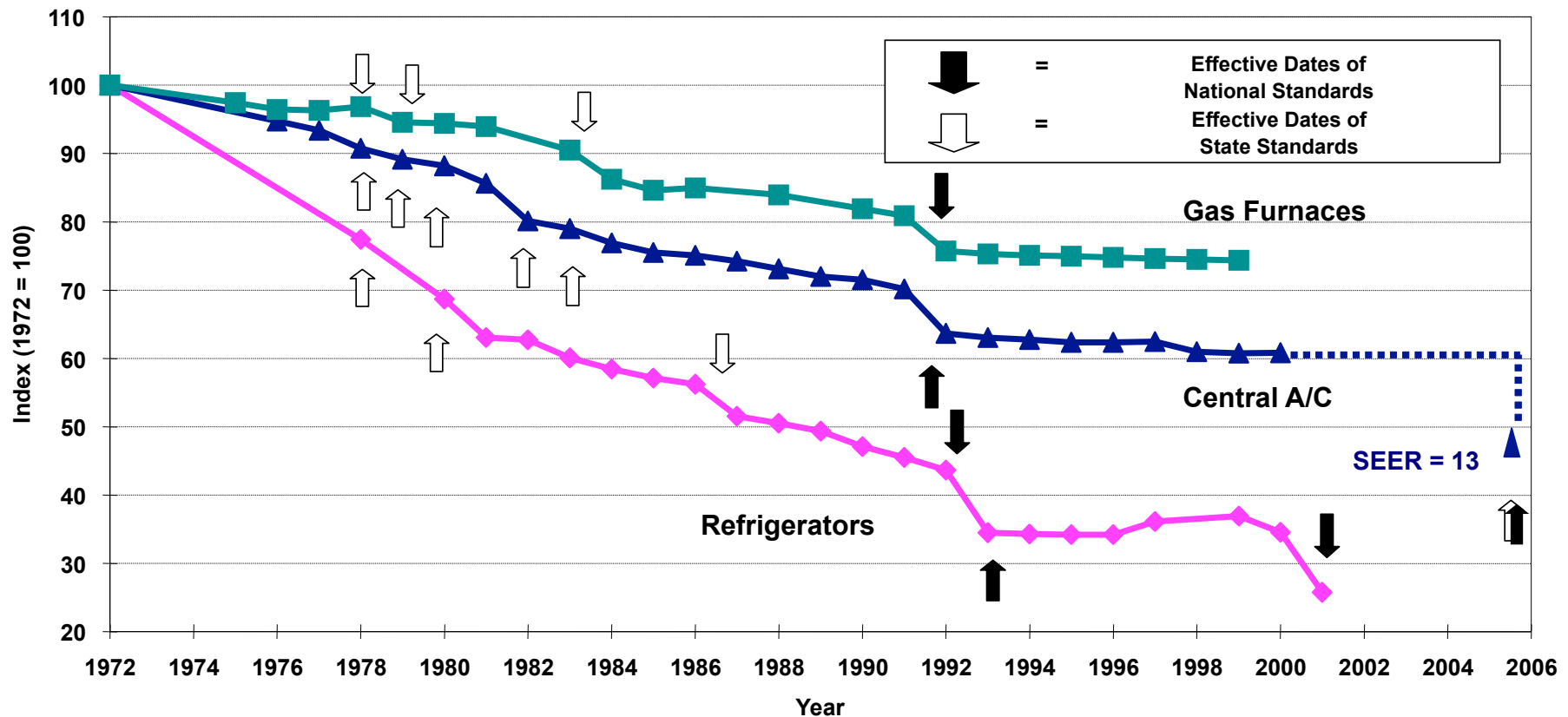
**Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2006 to 2008 are forecast data)**



Annual Energy Savings from Efficiency Programs and Standards

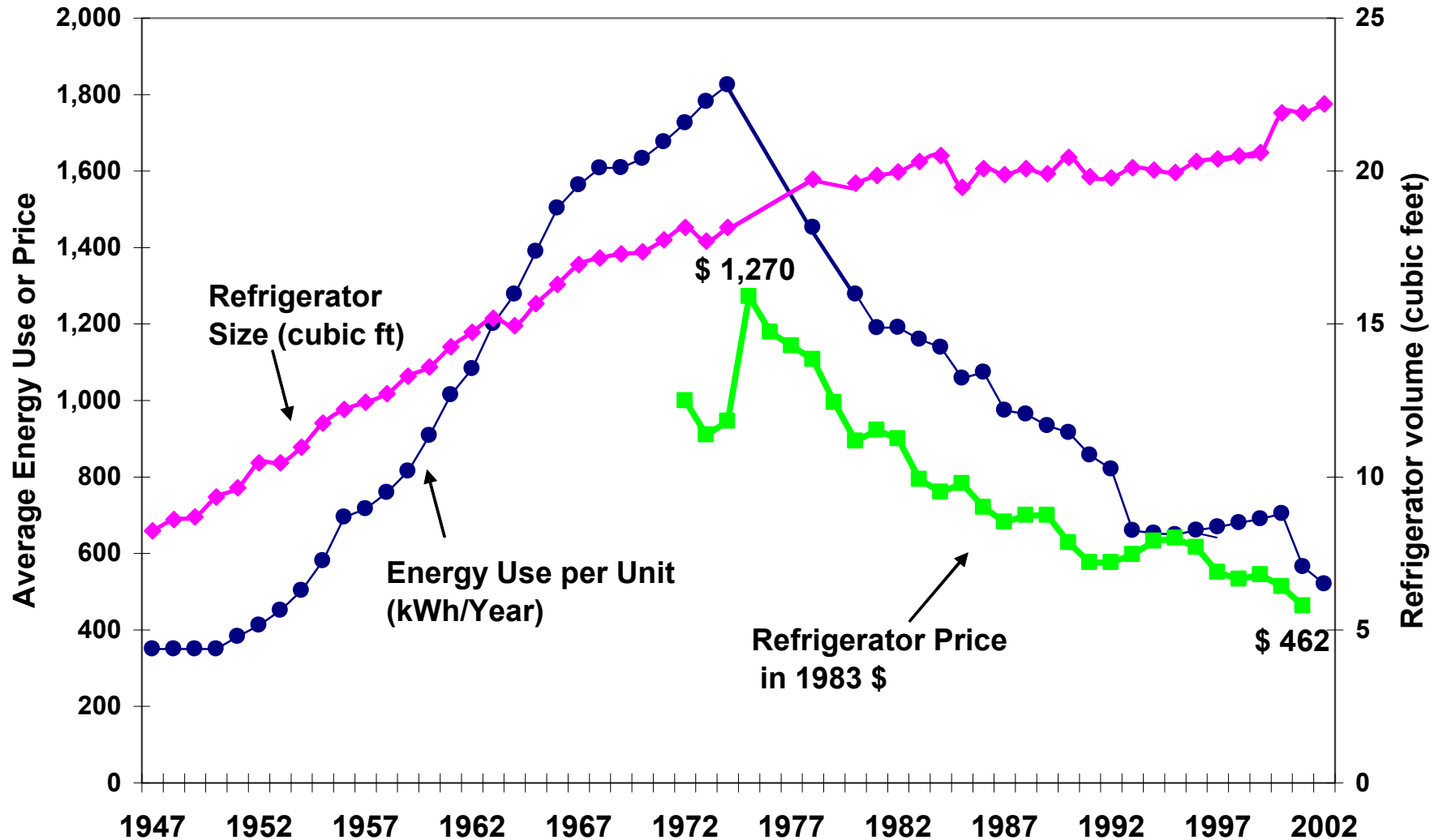


Impact of Standards on Efficiency of 3 Appliances



Source: S. Nadel, ACEEE,
in ECEEE 2003 Summer Study, www.eceee.org

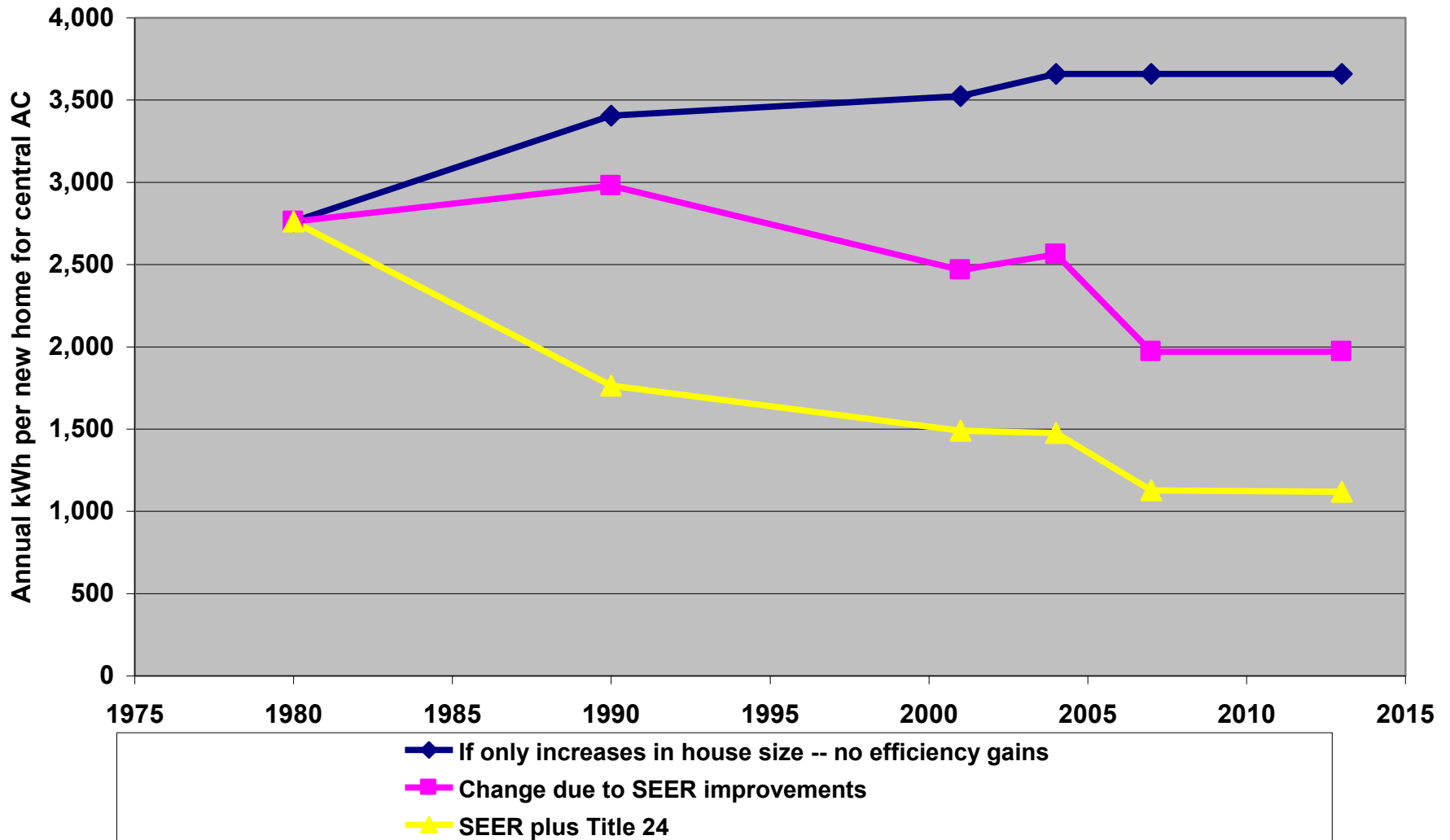
New United States Refrigerator Use v. Time and Retail Prices



Source: David Goldstein, NRDC, SF

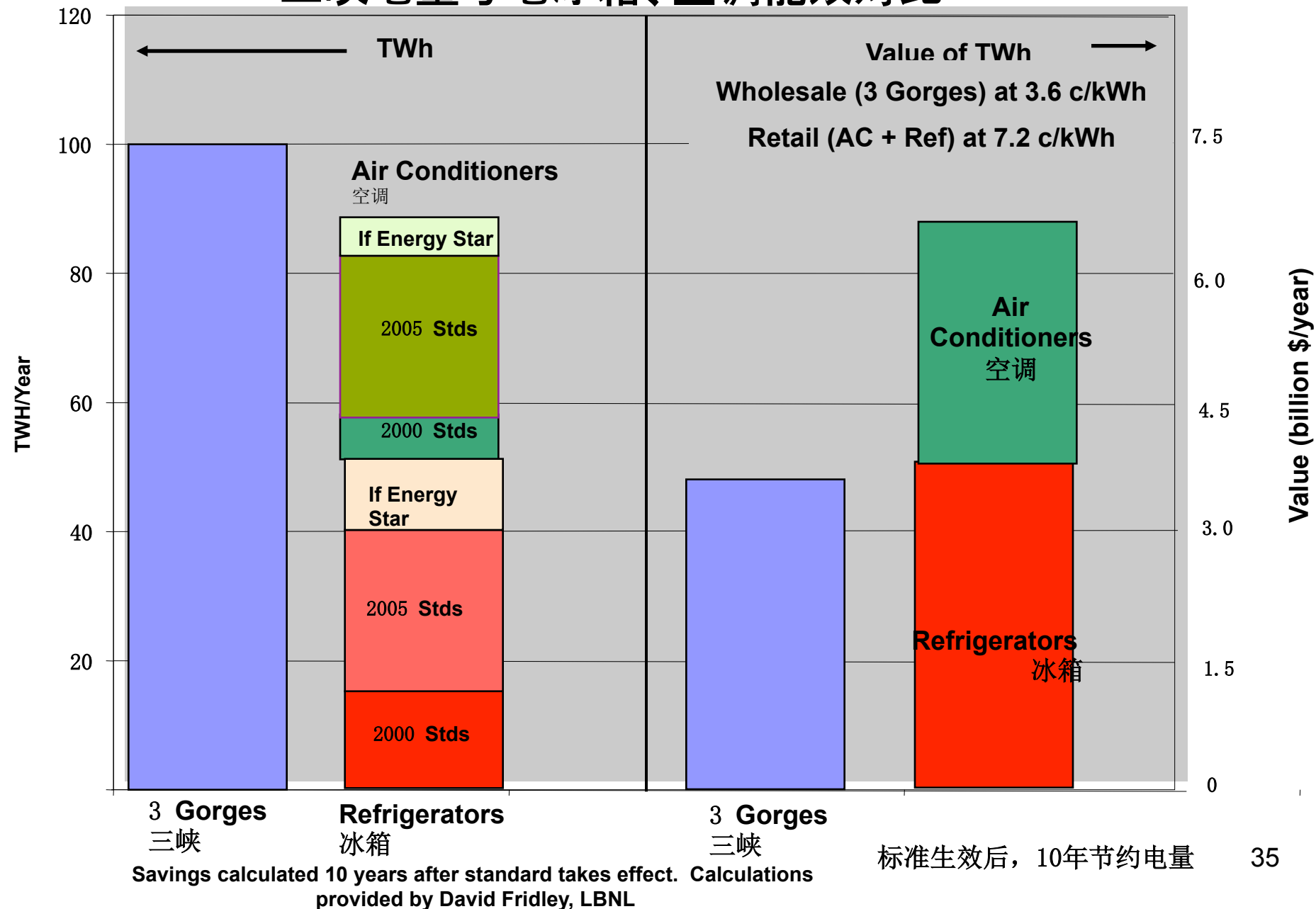
Air Conditioning Energy Use in Single Family Homes in PG&E

The effect of AC Standards (SEER) and Title 24 standards

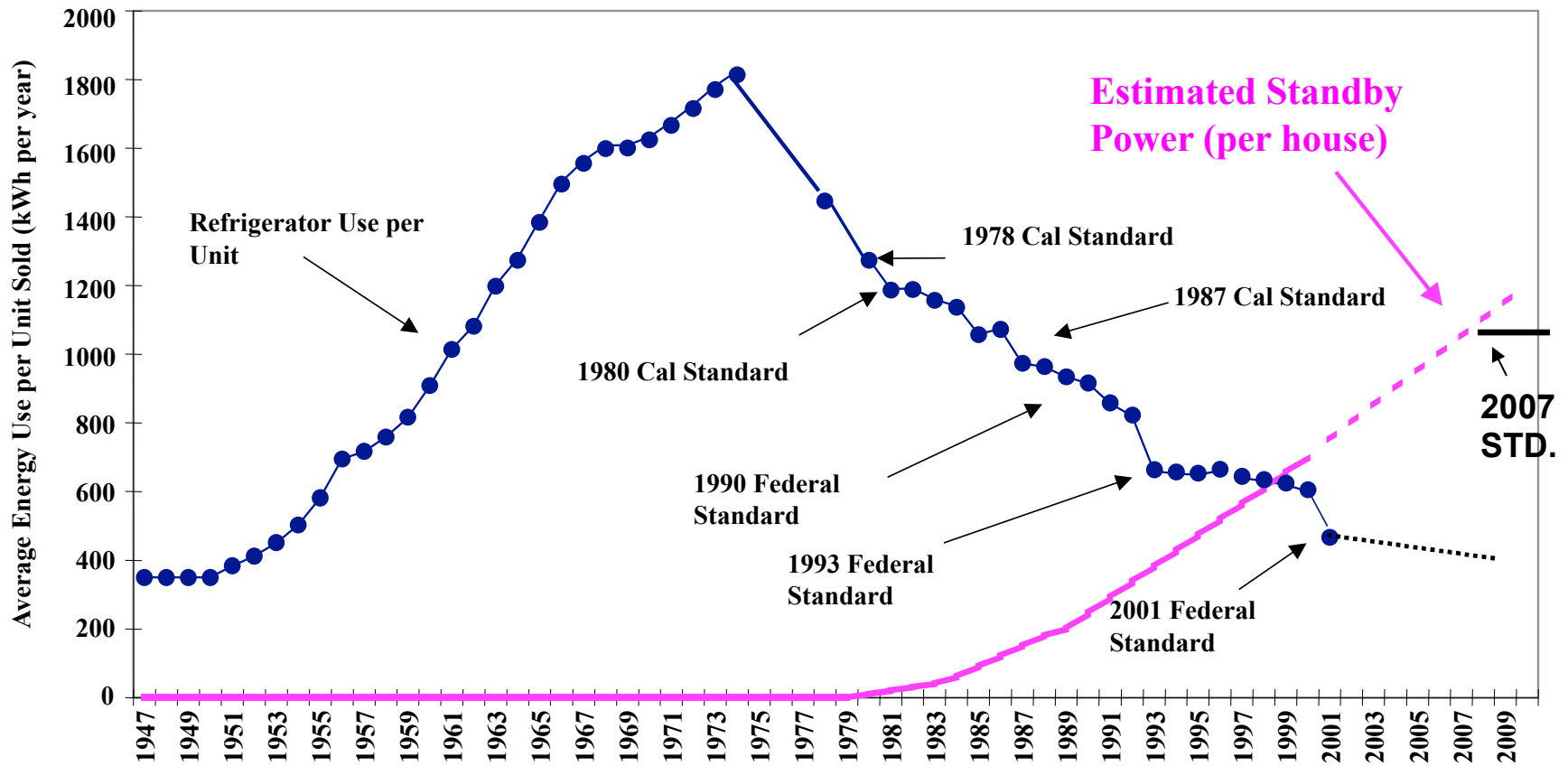


Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

三峡电量与电冰箱、空调能效对比



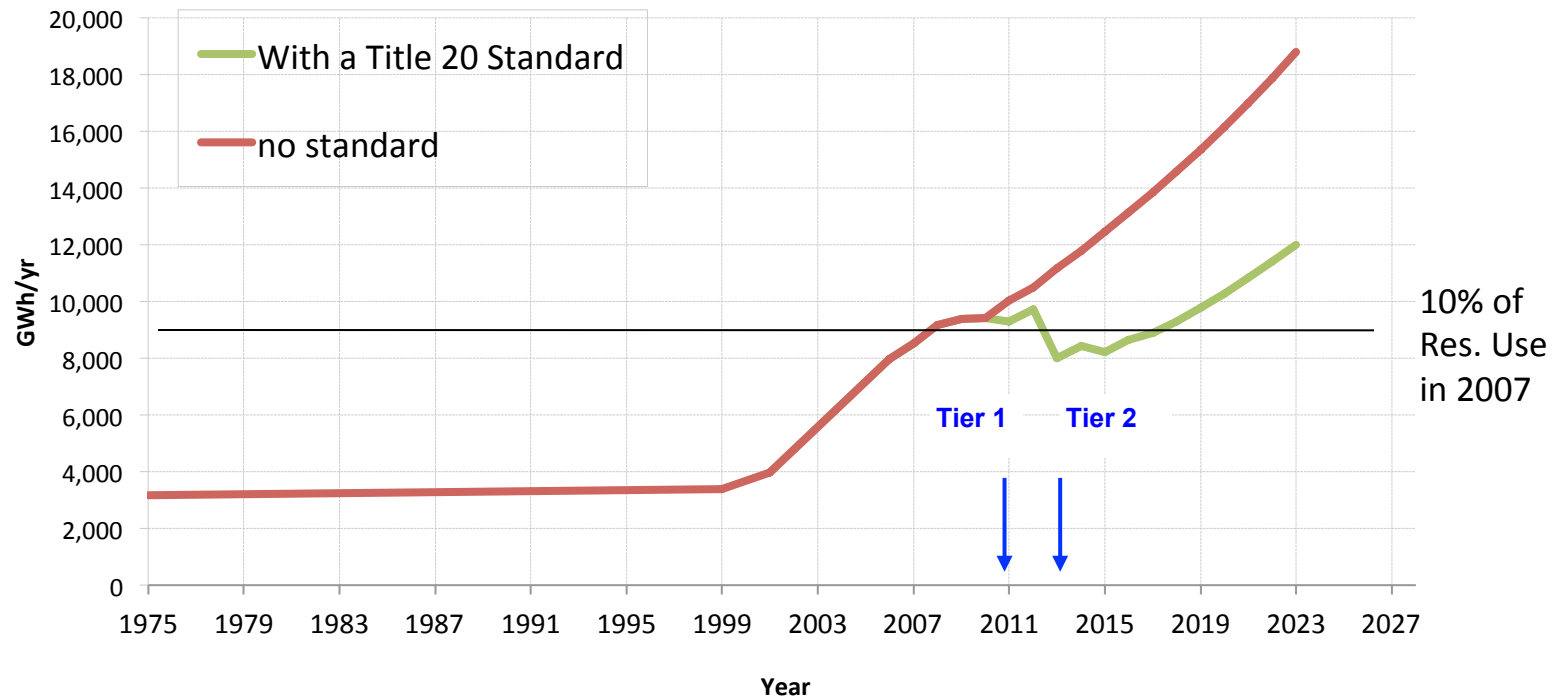
United States Refrigerator Use, repeated, to compare with Estimated Household Standby Use v. Time



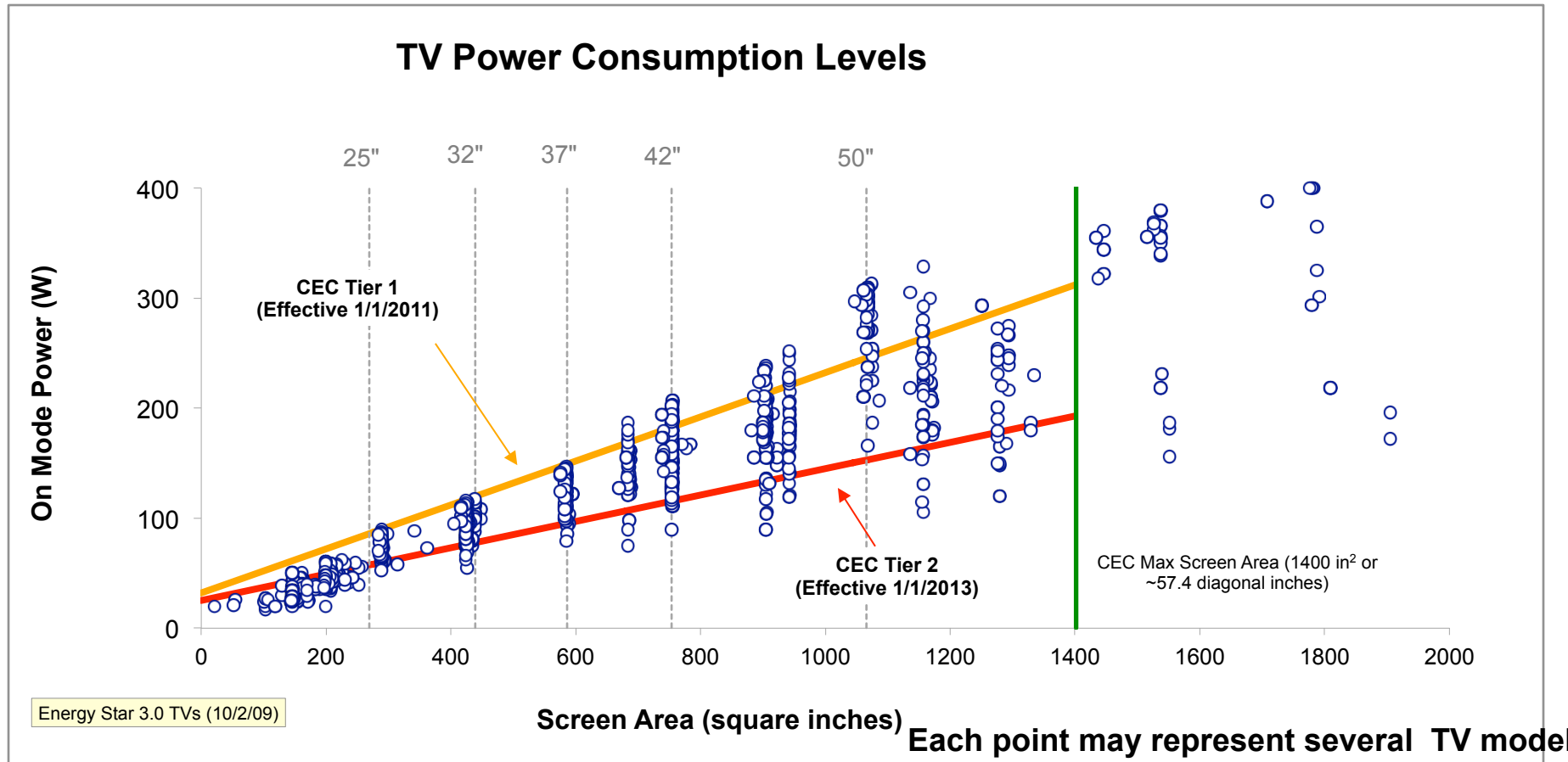
Televisions Represent Significant Energy Use

The residential energy consumption due to televisions rapidly increased from 3-4% in 1990s to 8-10% in 2008. Television energy will grow up to 18% by 2023 without regulations. The projected growth does not include the residential energy use by cable boxes, DVD players, internet boxes, Blue Ray, game consoles etc.

**California Energy Consumption from TVs
(Forecast with and without proposed standards)**



Technically Feasible Standards



***Consumers can expect to save between \$ 50 - \$ 250 over the life of their TV**

***A 50 inch plasma can consume as little as 307 kWh/yr and as much as 903 kWh/yr**

General Purpose Lighting – Proposed Regulations (cont.)

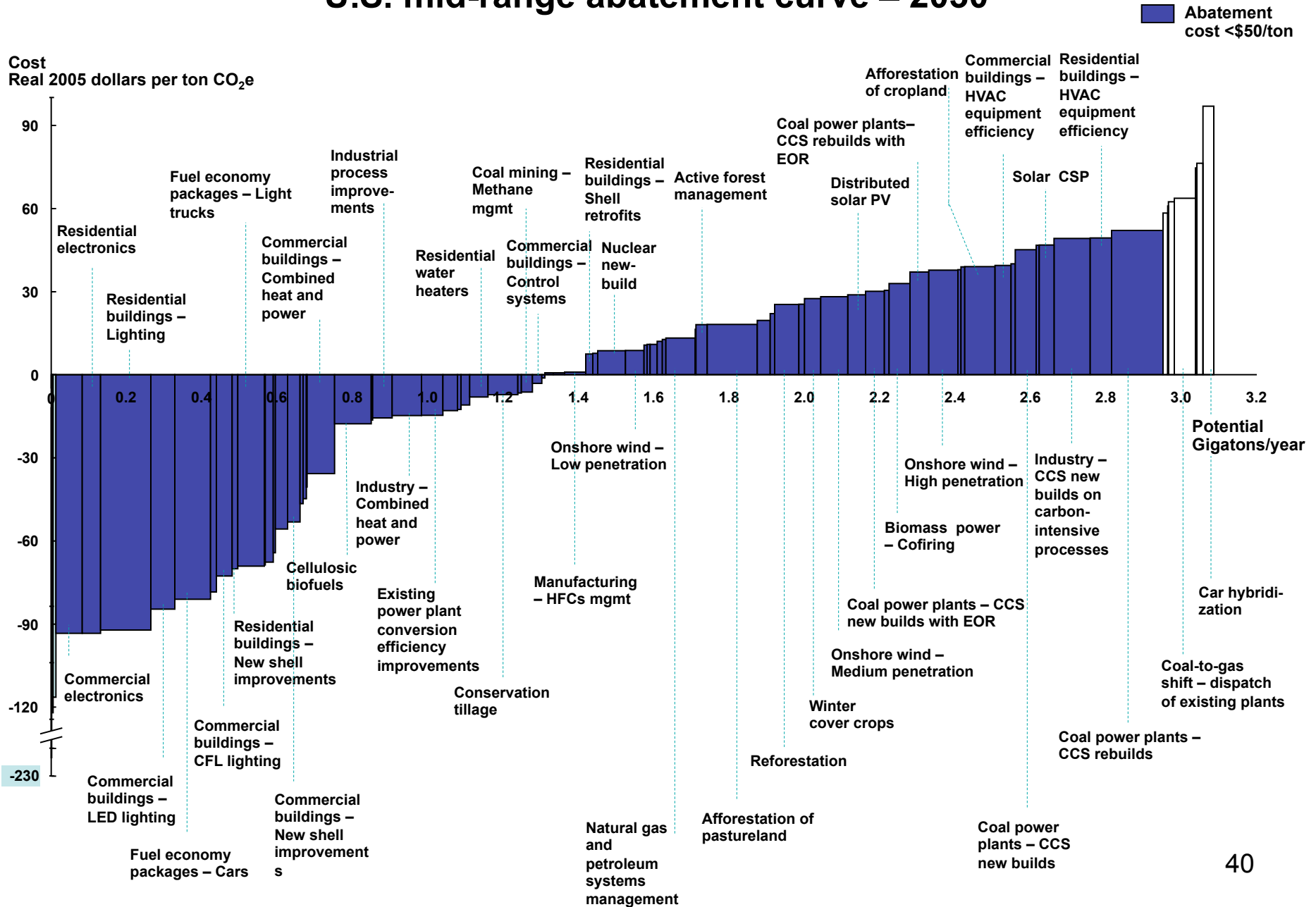
Proposed Table K-8: Standards for State-regulated General Services Incandescent Lamps -Tier I

Rated Lumens Range	Maximum rated Wattage	Minimum Rated Life Time	Proposed California Effective Date
1490-2600 Lumens	100→72 Watts	1,000 hours	Jan, 1, 2011
1050-1489 Lumens	75→53 Watts	1,000 hours	Jan 1, 2012
750-1049 Lumens	60→43 Watts	1,000 hours	Jan 1, 2013
310-749 Lumens	40→29 Watts	1,000 hours	Jan 1, 2013

Proposed Table K-9: Standards for State-regulated General Services Lamps -Tier II

Lumens Range	Maximum Lamp Efficacy	Minimum Rated Life Time	Proposed California Effective Date
All	45 lumens per watt	1,000 hours	Jan, 1, 2018

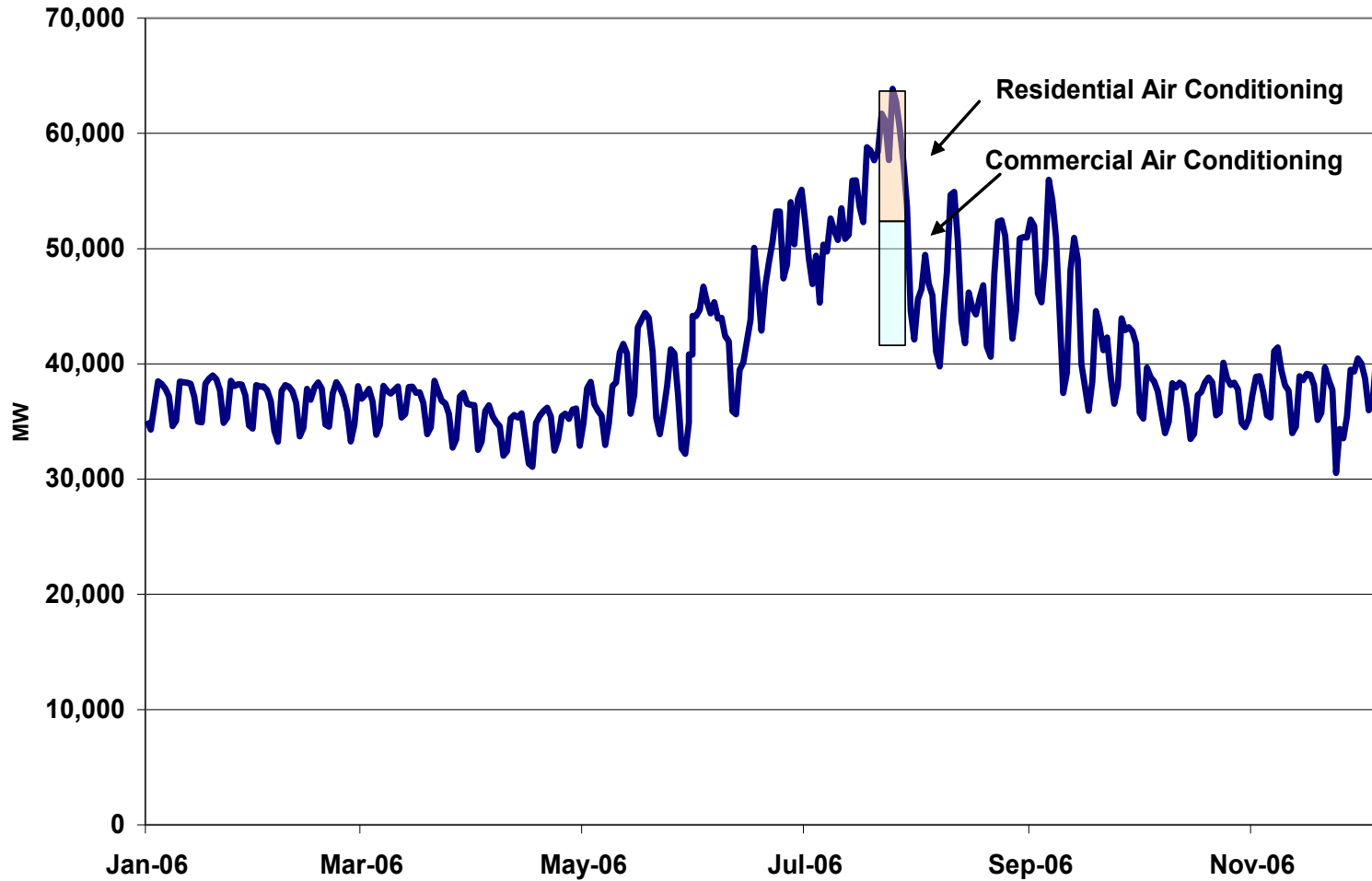
U.S. mid-range abatement curve – 2030



Demand Response

California is a Summer Peaking Area

California Daily Peak Loads -- 2006

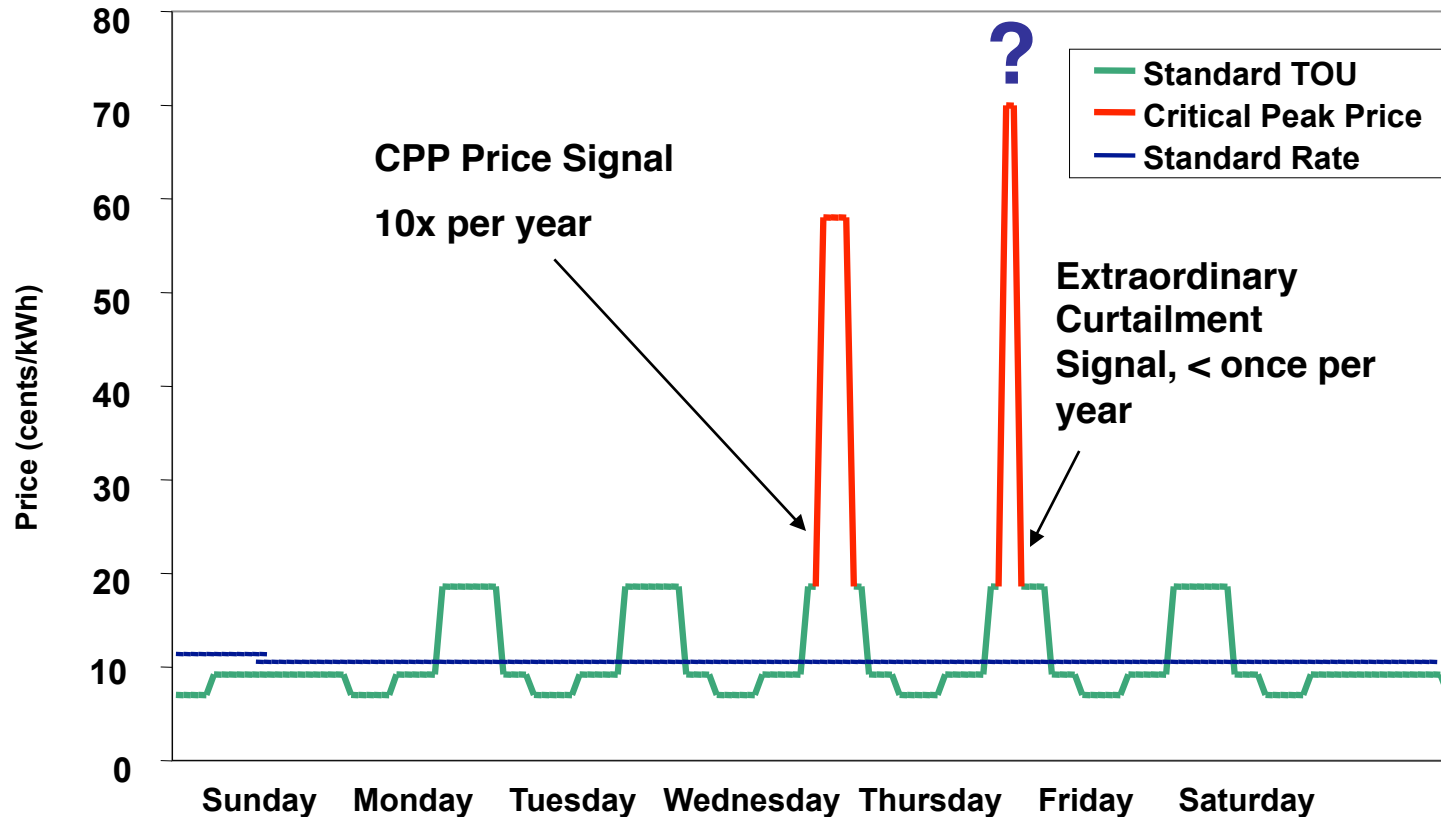


Three Necessary Components for Demand Response (The low-tech half of the smart grid; no Gee Whiz reliability)

- **Advanced Metering Infrastructure**--recorded hourly
 - Digital meters with communication; readings available in near-real time
- **Dynamic Tariffs**
 - Enable customers to be able to respond to hourly prices
 - The structure of these tariffs is critically important as customers are hoping to reduce total energy costs
- **Automated Response Technology** at customer locations
 - Enable residential and small commercial customers to respond to price **automatically**
 - Larger customers with energy management systems linked to pricing signals over the internet or through other communication channels
- And, when coupled with energy efficiency programs and policies the result can be reduction in total consumption as well as peak period consumption

Critical Peak Pricing (CPP) with Time of Use (TOU)

Direct customer savings comes mainly be response to TOU. Customer response to CPP is mainly civic pride but avoids utility investment and expensive peak infrastructure.

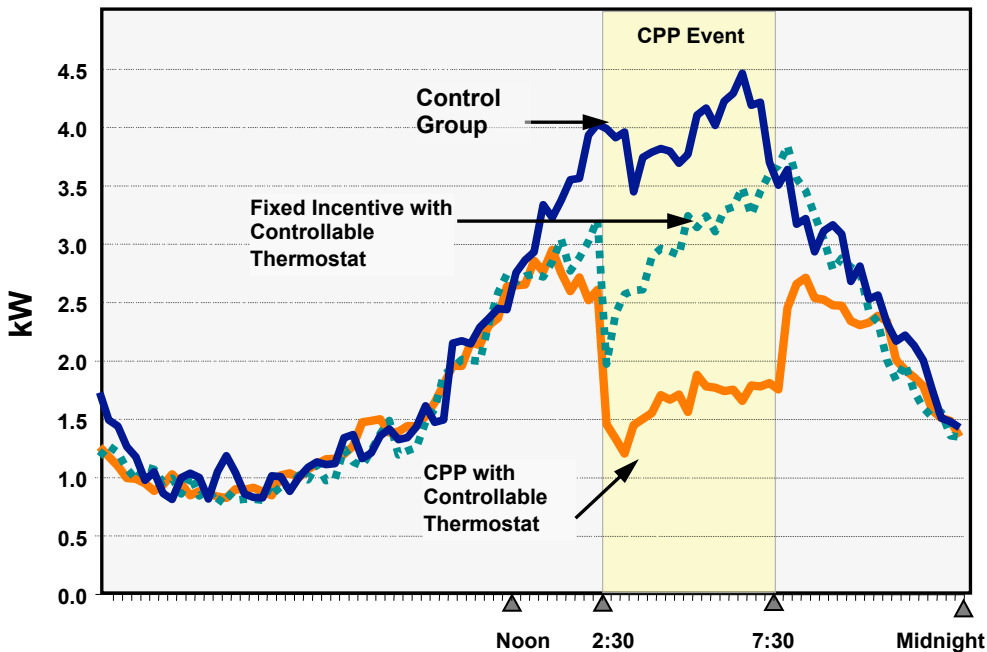


Prices are designed such that the average non-responder sees no bill change.

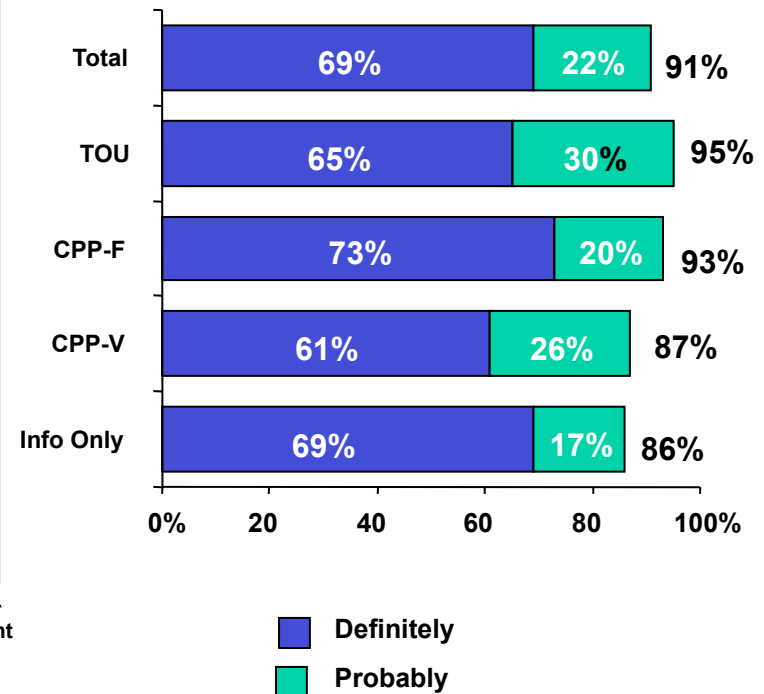
Key Results from Residential Pilot

- 12% average load reduction for CPP rate alone
- Up to 40% with rate + enabling tech
- Most participants preferred the pilot rates

Average Residential Response to Critical Peak Pricing

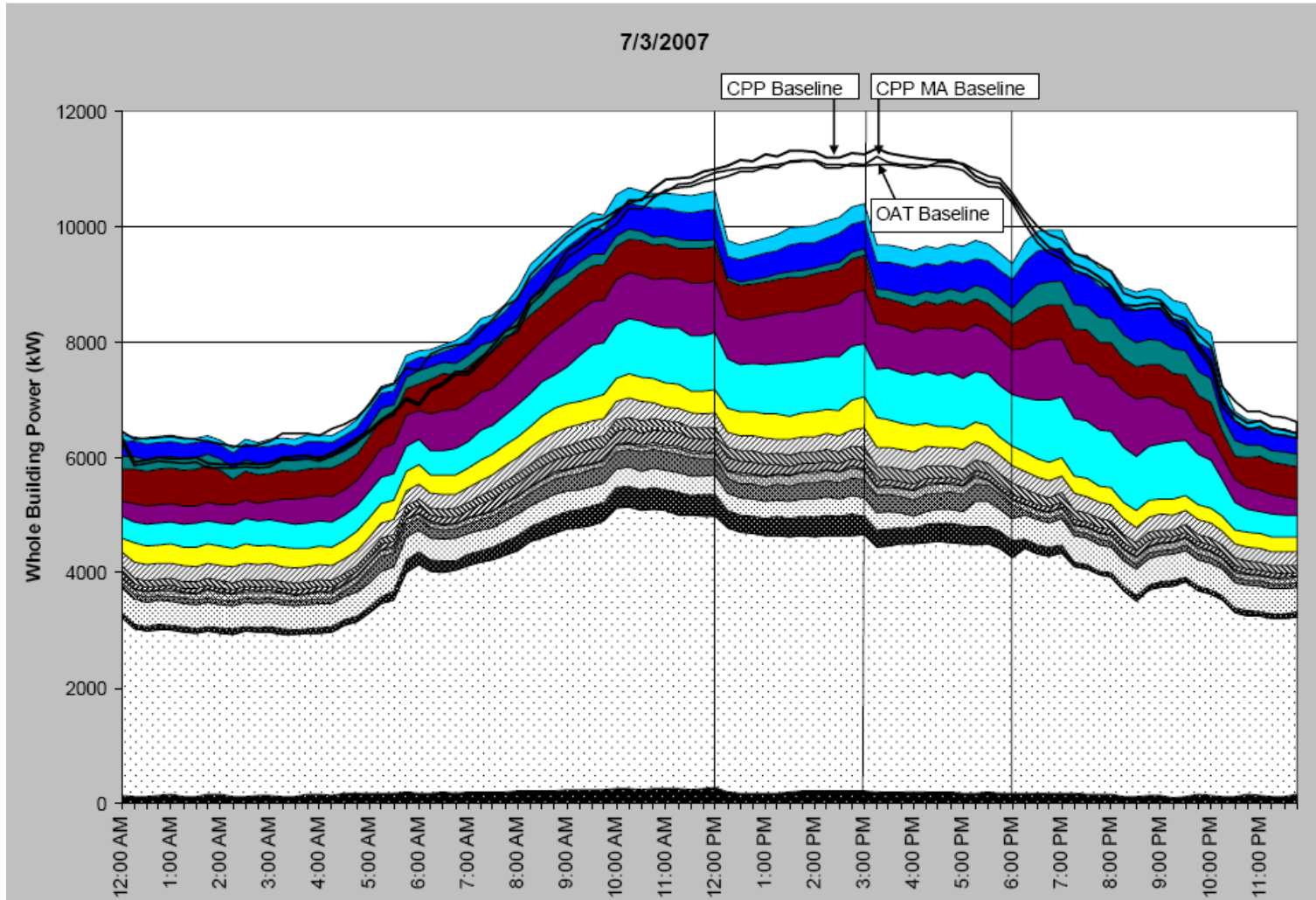


Should dynamic rates be offered to all customers?



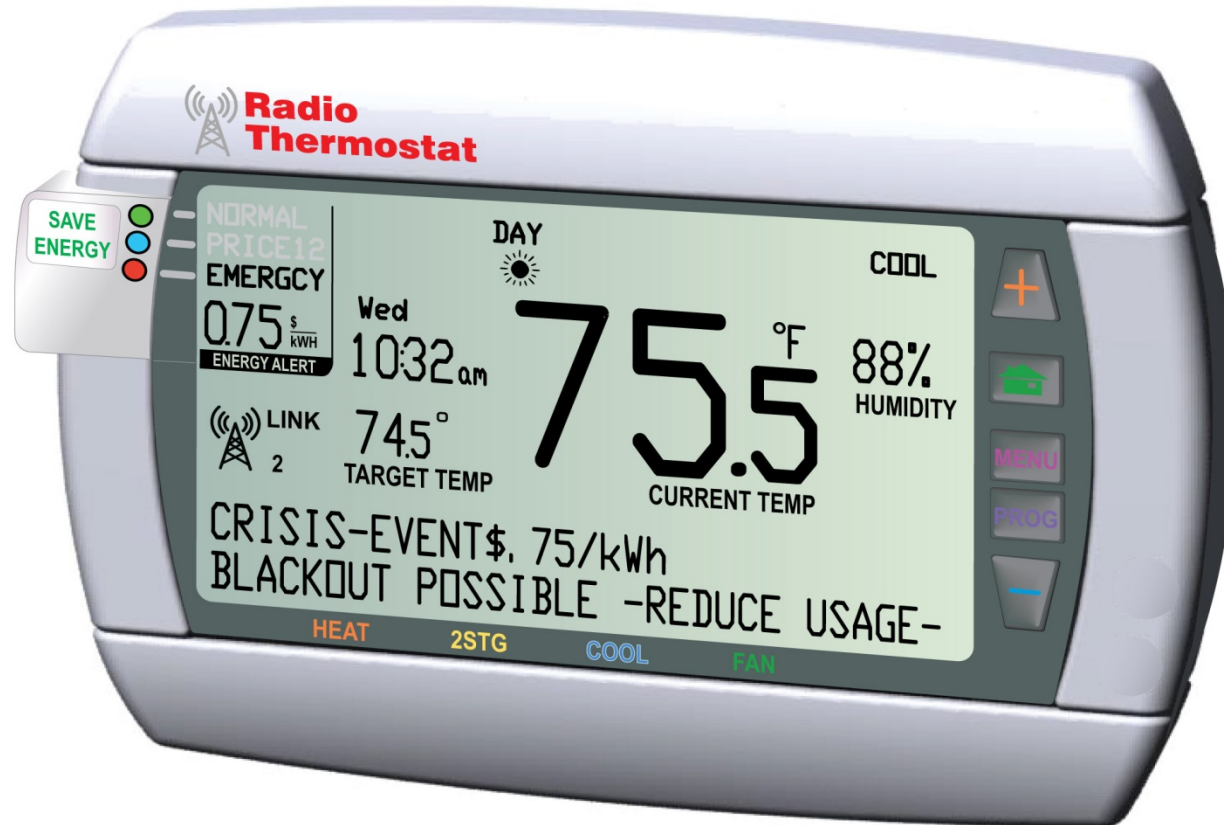
Automated Demand Response

Commercial Customers



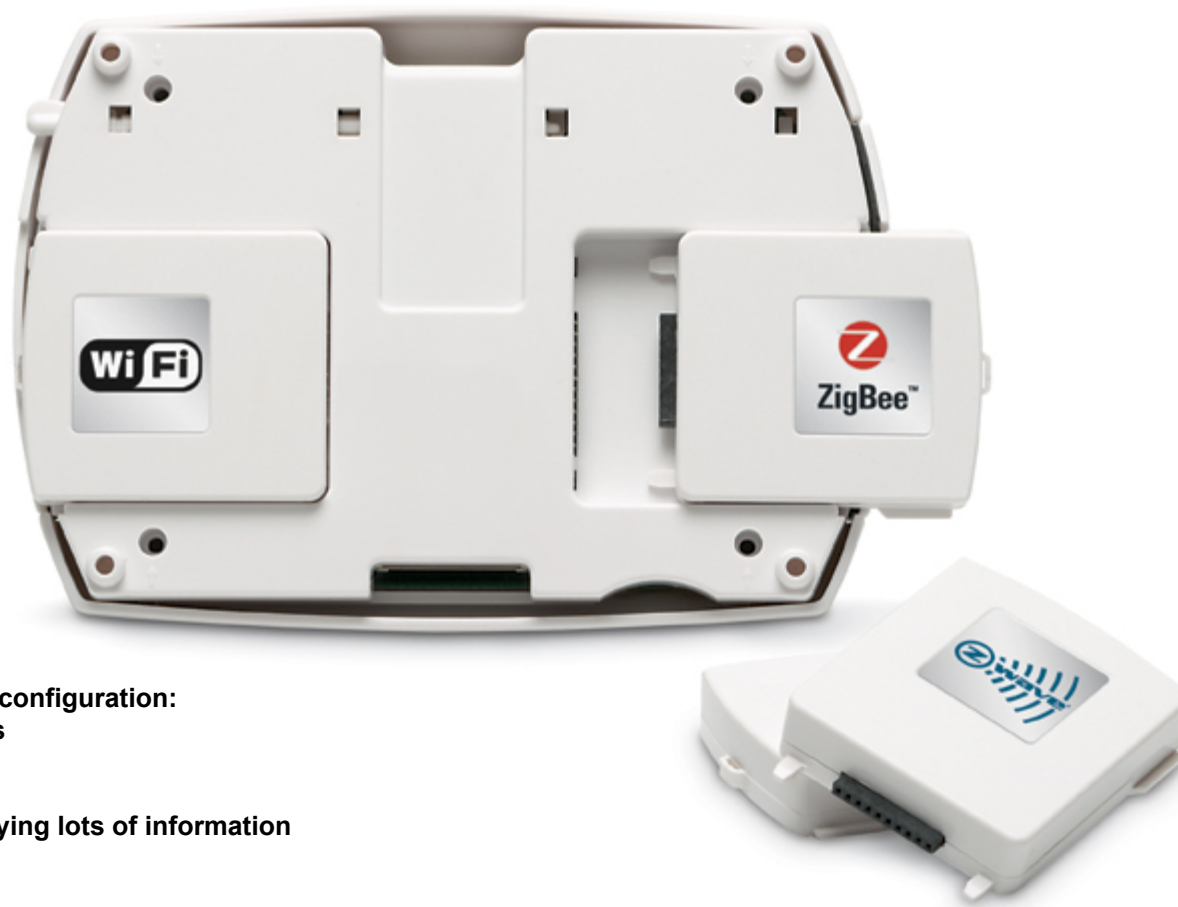
*Source: Demand Response Research Center, Global Energy Partners

Smart thermostat with universal communications interface at rear



Source: Tim Simons, Golden Power

Smart thermostat with U-SNAP Interface



Advantages of this configuration:

1. Customer decides
2. Flexible
3. "plug and play"
4. Capable of conveying lots of information

**Source: Tim Simons,
Golden Power**